

ATLAS Searches for New Physics at 13 TeV

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On Behalf of the ATLAS Collaboration

Status After Run-I

- Other than the SM Higgs no new particles discovered
- Limits of most Run-I searches around 1-2 TeV
 - Both SUSY and other BSM Theories
- Look to Run-II to discover what is beyond the SM
- Many search channels not yet sensitive but relaxed cuts have been used to validate analysis techniques and control regions

ATLAS SUSY Searches* - 95% CL Lower Limits

Status: July 2015

ATLAS Preliminary

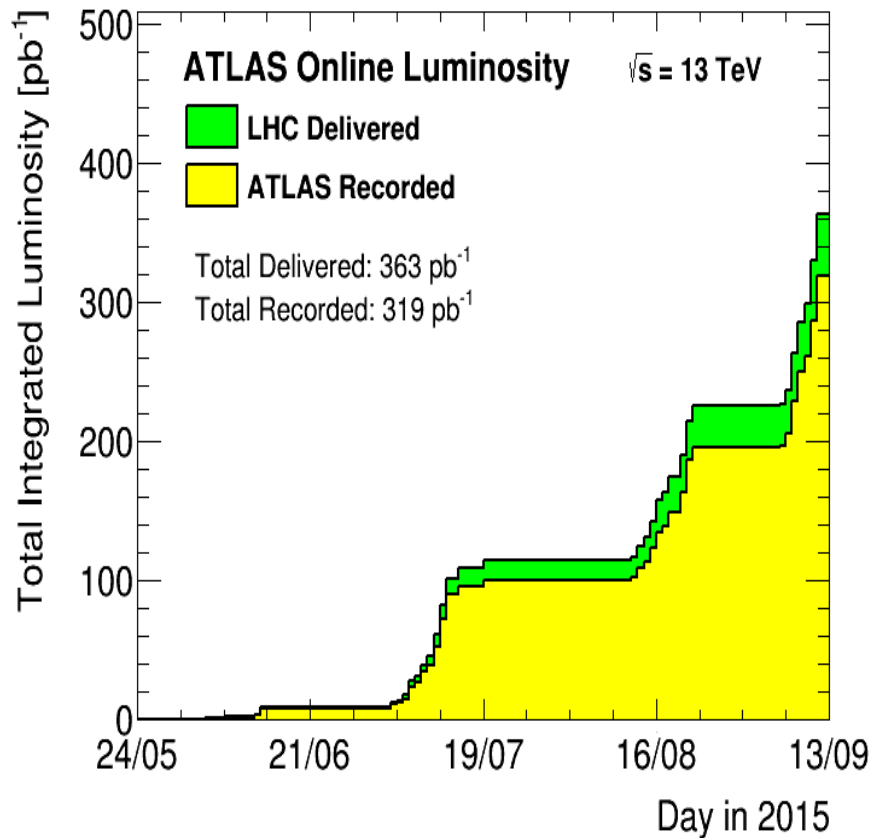
$\sqrt{s} = 7, 8 \text{ TeV}$

| Model | e, μ, τ, γ | Jets | E_T^{miss} | $[L d\Gamma(\text{fb}^{-1})]$ | Mass limit | $\sqrt{s} = 7 \text{ TeV}$ | $\sqrt{s} = 8 \text{ TeV}$ | Reference | |
|--|--|---------------------------|---------------------|-------------------------------|-------------------------|--|--|---|------------|
| Inclusive Searches | MSUGRA/CMSSM | 0-3 e, μ / 1-2 τ | 2-10 jets/3 b | Yes | 20.3 | \tilde{g}, \tilde{q} | 1.8 TeV | 1507.05525 | |
| | $\tilde{g}\tilde{g}, \tilde{q}\tilde{q} \rightarrow \tilde{g}\tilde{g}, \tilde{q}\tilde{q}$ | 0 | 2-6 jets | Yes | 20.3 | \tilde{g} | 850 GeV | 1405.7675 | |
| | mono-jet | 1-3 jets | Yes | 20.3 | \tilde{g} | 100-440 GeV | $m(\tilde{g})=0 \text{ GeV}, m(\tilde{t}^{\pm}) < 10 \text{ GeV}$ | 1507.05525 | |
| | $\tilde{g}\tilde{g}, \tilde{q}\tilde{q} \rightarrow \tilde{g}\tilde{g}(\ell(\ell\nu)\nu\nu)\tilde{q}_1^{\pm}$ (compressed) | 2 e, μ (off-Z) | 2 jets | Yes | 20.3 | \tilde{g} | 780 GeV | 1503.03290 | |
| | $\tilde{g}\tilde{g}, \tilde{q}\tilde{q} \rightarrow \tilde{g}\tilde{g}\tilde{q}_1^{\pm}$ | 0 | 2-6 jets | Yes | 20.3 | \tilde{g} | 83 TeV | 1405.7675 | |
| | $\tilde{g}\tilde{g}, \tilde{b}\tilde{b} \rightarrow \tilde{g}\tilde{g}\tilde{q}_1^{\pm}$ | 0-1 e, μ | 2-6 jets | Yes | 20 | \tilde{g} | 1 TeV | 1507.05525 | |
| | $\tilde{g}\tilde{g}, \tilde{b}\tilde{b} \rightarrow \tilde{g}\tilde{g}\tilde{q}_1^{\pm}$ | 2 e, μ | 0-3 jets | - | 20 | \tilde{g} | 1.2 TeV | 1501.03555 | |
| | $\tilde{g}\tilde{g}, \tilde{b}\tilde{b} \rightarrow \tilde{g}\tilde{g}(\ell(\ell\nu)\nu\nu)\tilde{q}_1^{\pm}$ | 1-2 τ + 0-1 ℓ | 0-2 jets | Yes | 20.3 | \tilde{g} | 1.6 TeV | 1407.0603 | |
| | GMSB (\tilde{g} NLSP) | 2 γ | - | Yes | 20.3 | \tilde{g} | 9 TeV | $c\tau(\text{NLSP}) < 0.1 \text{ mm}$ | 1507.05493 |
| | GGIM (bino NLSP) | γ | 1 b | Yes | 20.3 | \tilde{g} | 3 TeV | $m(\tilde{t}_1^{\pm}) < 900 \text{ GeV}, c\tau(\text{NLSP}) < 0.1 \text{ mm}, \mu < 0$ | 1507.05493 |
| GGIM (higgsino-bino NLSP) | γ | 2 jets | Yes | 20.3 | \tilde{g} | 1 TeV | $m(\tilde{t}_1^{\pm}) < 300 \text{ GeV}, c\tau(\text{NLSP}) < 0.1 \text{ mm}, \mu > 0$ | 1507.05493 | |
| GGIM (higgsino-bino NLSP) | 2 e, μ (Z) | 2 jets | Yes | 20.3 | \tilde{g} | 850 GeV | $m(\text{NLSP}) < 400 \text{ GeV}$ | 1503.03290 | |
| Gravitino LSP | 0 | mono-jet | Yes | 20.3 | $\tilde{g}^{1/2}$ scale | 865 GeV | $m(\tilde{g}) > 1.8 \times 10^{-14} \text{ eV}, m(\tilde{g}) = m(\tilde{g}) = 1.5 \text{ TeV}$ | 1502.01518 | |
| $\tilde{\nu}^{\mu}$ gen. & med. | $\tilde{g}\tilde{g}, \tilde{b}\tilde{b} \rightarrow \tilde{b}\tilde{b}\tilde{q}_1^{\pm}$ | 0 | 3 b | Yes | 20.1 | \tilde{g} | 1 TeV | 1407.0600 | |
| | $\tilde{g}\tilde{g}, \tilde{b}\tilde{b} \rightarrow \tilde{b}\tilde{b}\tilde{q}_1^{\pm}$ | 0 | 7-10 jets | Yes | 20.3 | \tilde{g} | 1.1 TeV | 1308.1941 | |
| | $\tilde{g}\tilde{g}, \tilde{b}\tilde{b} \rightarrow \tilde{b}\tilde{b}\tilde{q}_1^{\pm}$ | 0-1 e, μ | 3 b | Yes | 20.1 | \tilde{g} | 84 TeV | 1407.0600 | |
| | $\tilde{g}\tilde{g}, \tilde{b}\tilde{b} \rightarrow \tilde{b}\tilde{b}\tilde{q}_1^{\pm}$ | 0-1 e, μ | 3 b | Yes | 20.1 | \tilde{g} | 3 TeV | 1407.0600 | |
| $\tilde{\nu}^{\mu}$ gen. squarks & direct production | $\tilde{b}_1\tilde{b}_1, \tilde{b}_1\tilde{b}_1 \rightarrow \tilde{b}\tilde{b}\tilde{q}_1^{\pm}$ | 0 | 2 b | Yes | 20.1 | \tilde{b}_1 | 100-620 GeV | 1308.2631 | |
| | $\tilde{b}_1\tilde{b}_1, \tilde{b}_1\tilde{b}_1 \rightarrow \tilde{b}\tilde{b}\tilde{q}_1^{\pm}$ | 2 e, μ (SS) | 0-3 b | Yes | 20.3 | \tilde{b}_1 | 275-440 GeV | 1404.2500 | |
| | $\tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{b}\tilde{b}\tilde{q}_1^{\pm}$ | 1-2 e, μ | 1-2 b | Yes | 4.7/20.3 | \tilde{t}_1 | 110-167 GeV | 1209.2102, 1407.0583 | |
| | $\tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow W\tilde{b}_1^{\pm}$ or $\tilde{t}_1^{\pm}\tilde{t}_1^{\mp}$ | 0-2 e, μ | 0-2 jets/1-2 b | Yes | 20.3 | \tilde{t}_1 | 90-191 GeV | 1506.0816 | |
| | $\tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{q}\tilde{q}$ | 0 | mono-jet+tag | Yes | 20.3 | \tilde{t}_1 | 90-240 GeV | 1407.0606 | |
| | $\tilde{t}_1\tilde{t}_1$ (natural GMSB) | 2 e, μ (Z) | 1 b | Yes | 20.3 | \tilde{t}_1 | 150-580 GeV | 1403.5222 | |
| $\tilde{\nu}^{\mu}$ gen. squarks & direct production | $\tilde{b}_1\tilde{b}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{q}\tilde{q} + Z$ | 3 e, μ (Z) | 1 b | Yes | 20.3 | \tilde{b}_1 | 290-600 GeV | 1403.5222 | |
| | $\tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{q}\tilde{q}$ | 2 e, μ | 0 | Yes | 20.3 | \tilde{t}_1 | 90-325 GeV | 1403.5294 | |
| EW direct | $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}, \tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow \tilde{t}\tilde{t}^{\pm}$ | 2 e, μ | 0 | Yes | 20.3 | $\tilde{\chi}_1^{\pm}$ | 140-465 GeV | 1403.5294 | |
| | $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}, \tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow \tilde{t}\tilde{t}^{\pm}(\tilde{\nu})$ | 2 e, μ | 0 | Yes | 20.3 | $\tilde{\chi}_1^{\pm}$ | 100-350 GeV | 1407.0350 | |
| | $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}, \tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow \tilde{t}\tilde{t}^{\pm}(\tilde{\nu})$ | 2 τ | - | Yes | 20.3 | $\tilde{\chi}_1^{\pm}$ | 100-350 GeV | 1402.7029 | |
| | $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}, \tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow \tilde{t}\tilde{t}^{\pm}(\tilde{\nu}\nu), \tilde{t}\tilde{t}^{\pm}(\tilde{\nu}\nu)$ | 3 e, μ | 0 | Yes | 20.3 | $\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^{\pm}$ | 700 GeV | 1402.7029 | |
| | $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}, \tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow W\tilde{q}_1^{\pm}\tilde{Z}$ | 2-3 e, μ | 0-2 jets | Yes | 20.3 | $\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^{\pm}$ | 420 GeV | 1403.5294, 1402.7029 | |
| | $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}, \tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow W\tilde{q}_1^{\pm}h, \tilde{h} \rightarrow \tilde{b}\tilde{b}(WW)\tau\tau/\gamma\gamma$ | e, μ, γ | 0-2 b | Yes | 20.3 | $\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^{\pm}$ | 250 GeV | 1501.07110 | |
| | $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}, \tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow \tilde{q}\tilde{q}$ | 4 e, μ | 0 | Yes | 20.3 | $\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^{\pm}$ | 620 GeV | 1405.5086 | |
| | GGIM (wino NLSP) weak prod. | 1 $e, \mu + \gamma$ | - | Yes | 20.3 | \tilde{W} | 124-361 GeV | 1507.05493 | |
| | Direct $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}$ prod., long-lived $\tilde{\chi}_1^{\pm}$ | Disapp. trk | 1 jet | Yes | 20.3 | $\tilde{\chi}_1^{\pm}$ | 270 GeV | $m(\tilde{t}_1^{\pm}) = m(\tilde{t}_2^{\pm}) < 160 \text{ MeV}, c\tau(\tilde{\chi}_1^{\pm}) = 0.2 \text{ ns}$ | 1310.3675 |
| | Direct $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}$ prod., long-lived $\tilde{\chi}_1^{\pm}$ | dEdx trk | - | Yes | 18.4 | $\tilde{\chi}_1^{\pm}$ | 482 GeV | $m(\tilde{t}_1^{\pm}) = m(\tilde{t}_2^{\pm}) < 190 \text{ MeV}, c\tau(\tilde{\chi}_1^{\pm}) < 1.5 \text{ ns}$ | 1506.05332 |
| Stable \tilde{g} R-hadron | 0 | 1-5 jets | Yes | 27.9 | \tilde{g} | 832 GeV | $m(\tilde{t}_1^{\pm}) < 100 \text{ GeV}, 10 \mu\text{s} < c\tau(\tilde{g}) < 1000 \text{ s}$ | 1310.6584 | |
| Stable \tilde{g} R-hadron | trk | - | - | 19.1 | \tilde{g} | 1 TeV | 1411.6795 | | |
| GMSB, stable $\tilde{g}, \tilde{\chi}_1^{\pm} \rightarrow \tilde{t}\tilde{t}^{\pm}, \tilde{\mu}\tilde{\mu}^{\pm}(e, \mu)$ | 1-2 μ | - | - | 19.1 | $\tilde{\chi}_1^{\pm}$ | 537 GeV | $10 < \tan\beta < 50$ | 1411.6795 | |
| GMSB, $\tilde{\chi}_1^{\pm} \rightarrow \gamma\tilde{G}$, long-lived $\tilde{\chi}_1^{\pm}$ | 2 γ | - | Yes | 20.3 | $\tilde{\chi}_1^{\pm}$ | 435 GeV | $2 < c\tau(\tilde{\chi}_1^{\pm}) < 3 \text{ ns}, \text{SPS8 model}$ | 1409.5542 | |
| GGIM $\tilde{g}\tilde{g}, \tilde{\chi}_1^{\pm} \rightarrow \tilde{e}\tilde{e}/\tilde{\mu}\tilde{\mu}/\tilde{\nu}\tilde{\nu}$ | displ. ee/eq/μμ | - | - | 20.3 | $\tilde{\chi}_1^{\pm}$ | 1.0 TeV | $7 < c\tau(\tilde{\chi}_1^{\pm}) < 740 \text{ mm}, m(\tilde{g}) = 1.3 \text{ TeV}$ | 1504.05162 | |
| GGIM $\tilde{g}\tilde{g}, \tilde{\chi}_1^{\pm} \rightarrow \tilde{Z}\tilde{G}$ | displ. vtx + jets | - | - | 20.3 | $\tilde{\chi}_1^{\pm}$ | 1.0 TeV | $6 < c\tau(\tilde{\chi}_1^{\pm}) < 480 \text{ mm}, m(\tilde{g}) = 1.1 \text{ TeV}$ | 1504.05162 | |
| RPV | LFV $pp \rightarrow \tilde{\nu}\tau + X, \tilde{\nu}\tau \rightarrow e\mu/\tau\mu/\tau\tau$ | $e\mu, e\tau, \mu\tau$ | - | - | 20.3 | $\tilde{\nu}$ | 1.7 TeV | $A_{131333233} = 0.07$ | 1503.04430 |
| | Bilinear RPV CMSSM | 2 e, μ (SS) | 0-3 b | Yes | 20.3 | \tilde{g}, \tilde{q} | 35 TeV | $m(\tilde{g}) = m(\tilde{g}), c\tau_{\mu\mu} < 1 \text{ mm}$ | 1404.2500 |
| | $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}, \tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow W\tilde{q}_1^{\pm}\tilde{q}_1^{\pm}, \tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow e\tilde{e}\tilde{\nu}, e\tilde{\mu}\tilde{\nu}$ | 4 e, μ | - | Yes | 20.3 | $\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^{\pm}$ | 750 GeV | $m(\tilde{t}_1^{\pm}) > 0.2 m(\tilde{t}_2^{\pm}), A_{1313} = 0$ | 1405.5086 |
| | $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}, \tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow W\tilde{q}_1^{\pm}\tilde{q}_1^{\pm}, \tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp} \rightarrow \tau\tilde{\nu}\tilde{\nu}, e\tilde{\nu}\tilde{\nu}$ | 3 $e, \mu + \tau$ | - | Yes | 20.3 | $\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^{\pm}$ | 450 GeV | $m(\tilde{t}_1^{\pm}) > 0.2 m(\tilde{t}_2^{\pm}), A_{1313} = 0$ | 1405.5086 |
| | $\tilde{g}\tilde{g}, \tilde{b}\tilde{b} \rightarrow \tilde{q}\tilde{q}\tilde{q}_1^{\pm}$ | 0 | 6-7 jets | - | 20.3 | \tilde{g} | 917 GeV | $\text{BR}(\tilde{g} \rightarrow b\tilde{q}) = \text{BR}(\tilde{g} \rightarrow t\tilde{q}) = 0\%$ | 1502.05686 |
| | $\tilde{g}\tilde{g}, \tilde{b}\tilde{b} \rightarrow \tilde{q}\tilde{q}\tilde{q}_1^{\pm}$ | 0 | 6-7 jets | - | 20.3 | \tilde{g} | 870 GeV | $m(\tilde{t}_1^{\pm}) = 900 \text{ GeV}$ | 1502.05686 |
| | $\tilde{g}\tilde{g}, \tilde{b}\tilde{b} \rightarrow \tilde{q}\tilde{q}\tilde{q}_1^{\pm}$ | 2 e, μ (SS) | 0-3 b | Yes | 20.3 | \tilde{g} | 850 GeV | 1404.250 | |
| $\tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{b}\tilde{b}\tilde{q}_1^{\pm}$ | 0 | 2 jets + 2 b | - | 20.3 | \tilde{t}_1 | 100-308 GeV | ATLAS-CONF-2015-026 | | |
| $\tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{b}\tilde{b}\tilde{q}_1^{\pm}$ | 2 e, μ | 2 b | - | 20.3 | \tilde{t}_1 | 0.4-1.0 TeV | ATLAS-CONF-2015-015 | | |
| Other | Scalar charm, $\tilde{c} \rightarrow \tilde{c}\tilde{q}_1^{\pm}$ | 0 | 2 c | Yes | 20.3 | \tilde{c} | 490 GeV | $m(\tilde{t}_1^{\pm}) < 200 \text{ GeV}$ | 1501.01325 |

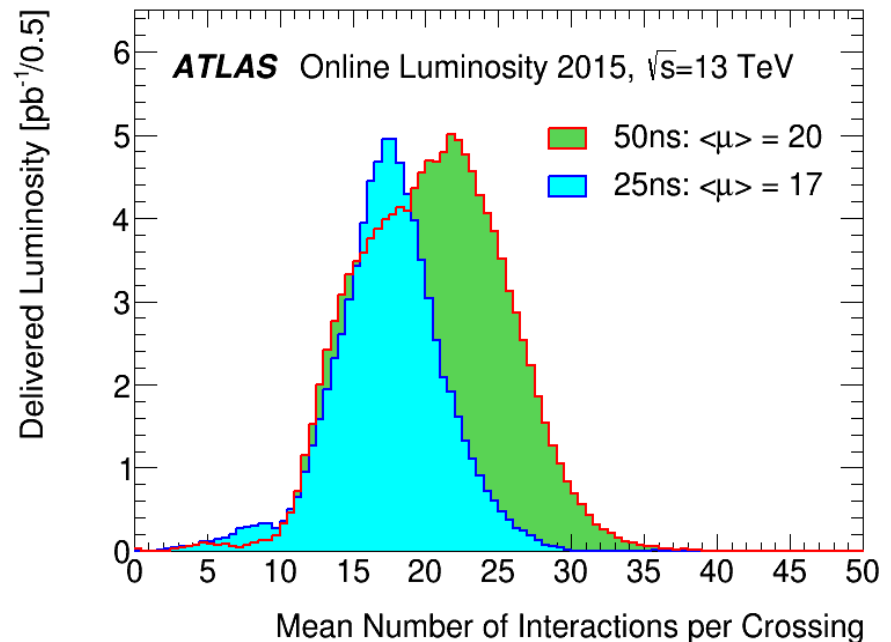
*Only a selection of the available mass limits on new states or phenomena is shown. All limits quoted are observed minus 1 σ theoretical signal cross section uncertainty.

1 TeV

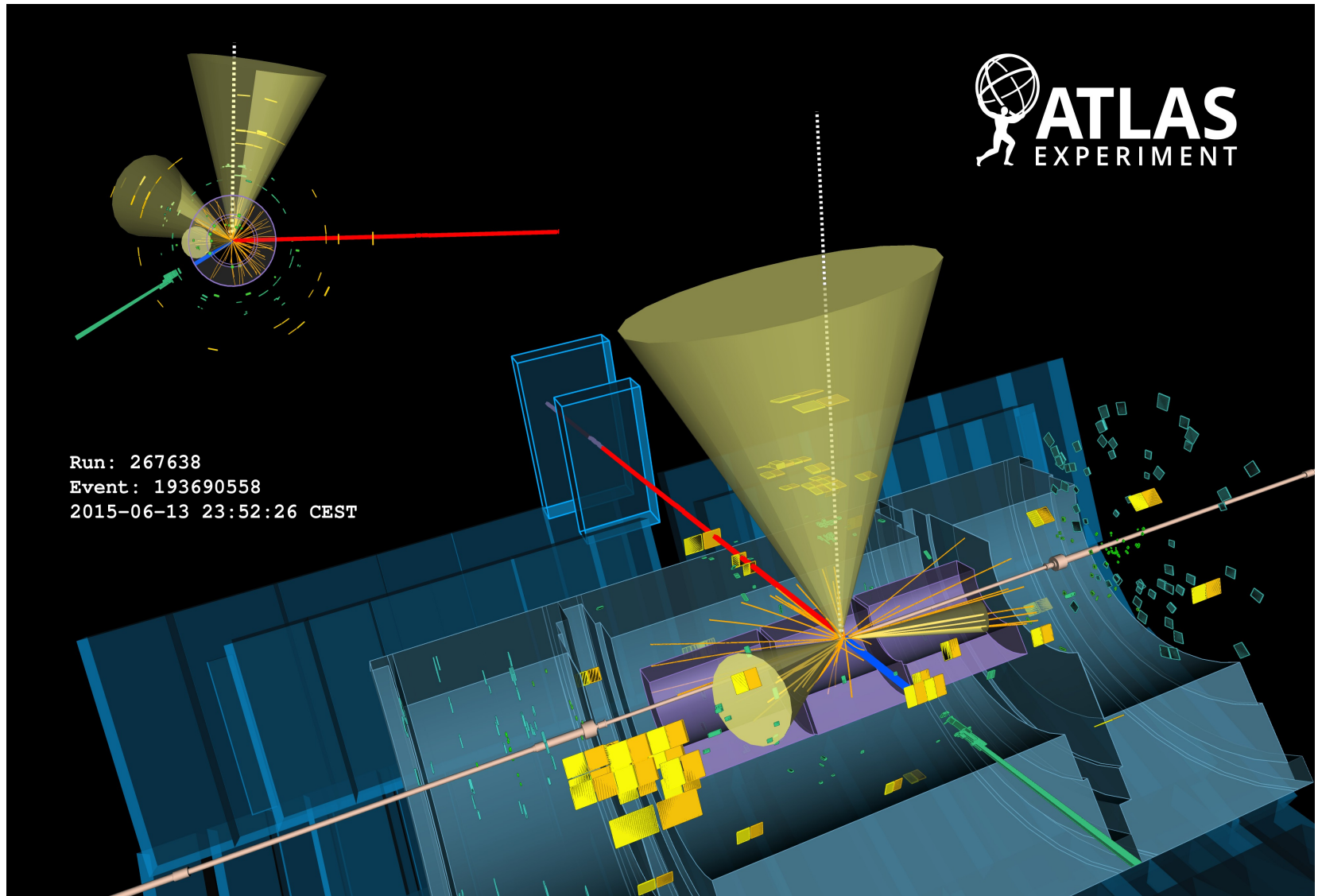
LHC Run-II



- ATLAS has recorded a total of 319 pb⁻¹ recorded
- Two data taking periods already used for physics
 - 50 ns with $\langle\mu\rangle = 20$
 - 25 ns with $\langle\mu\rangle = 17$
 - Results shown for one or the other



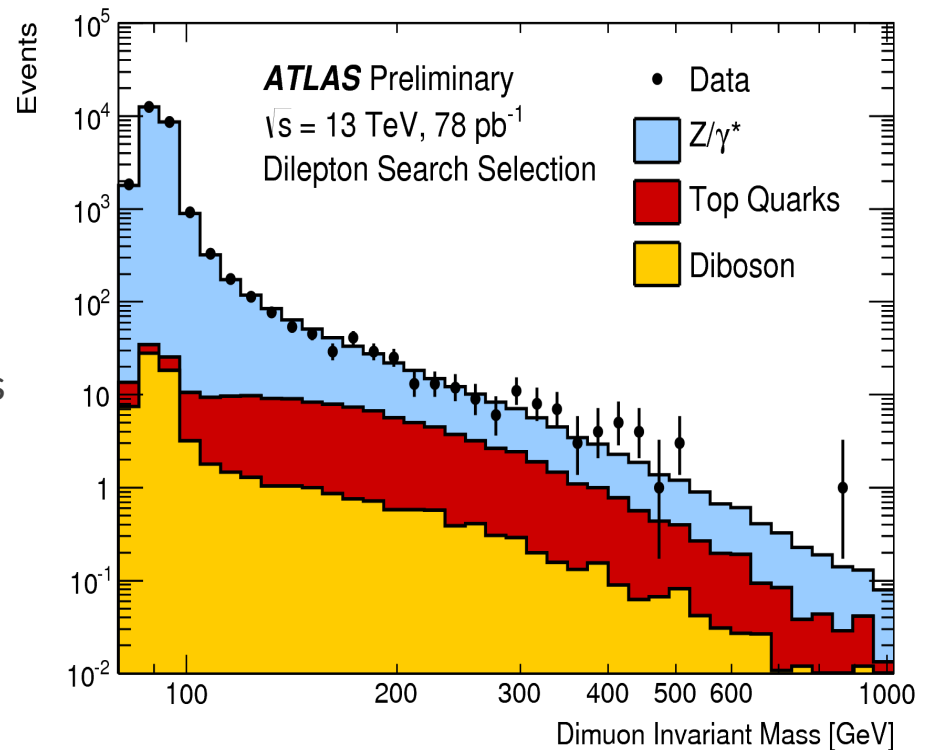
First Look at New Energies



Di-Lepton Final States ($ee, \mu\mu$)

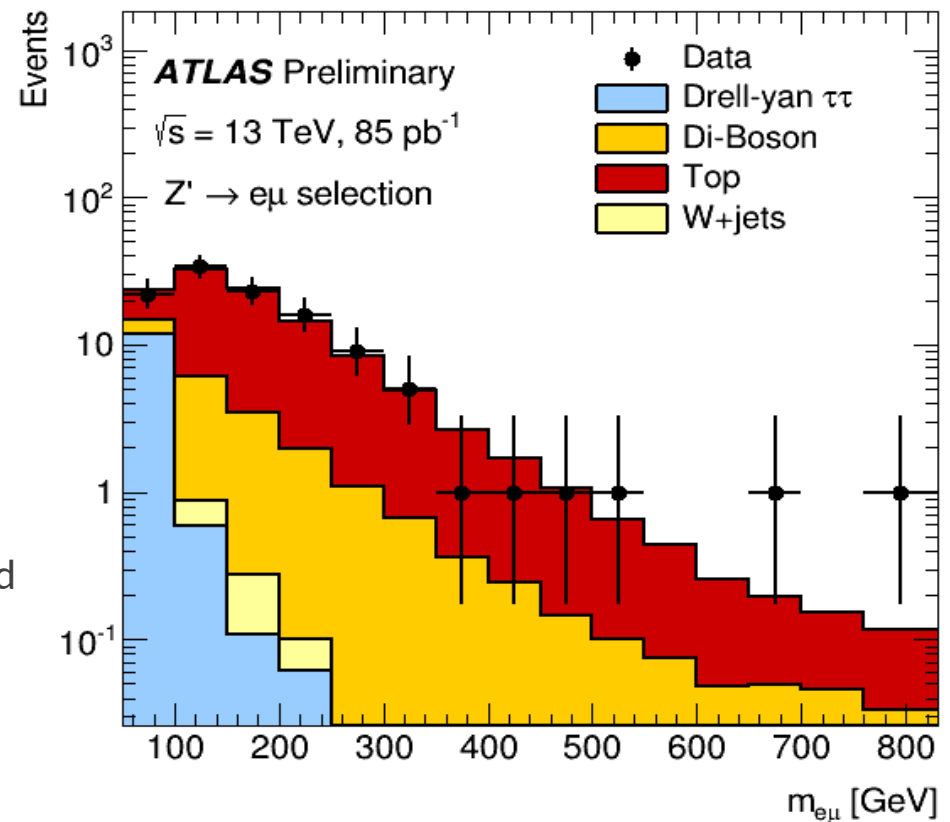
EXOT-2015-001

- Search for neutral resonances decaying to lepton pairs
 - Sign of a new fundamental symmetry
- Single lepton trigger selects events
 - Require two isolated leptons
 - $p_T > 30$ GeV, & $|\eta| < 2.5$
- Calculate invariant mass of lepton pairs
 - Normalize MC prediction to observed data in window around the Z peak
 - $80 < m_{ll} < 120$ GeV
- Highest mass di-electron event at 740 GeV
- Highest mass di-muon event at 881 GeV

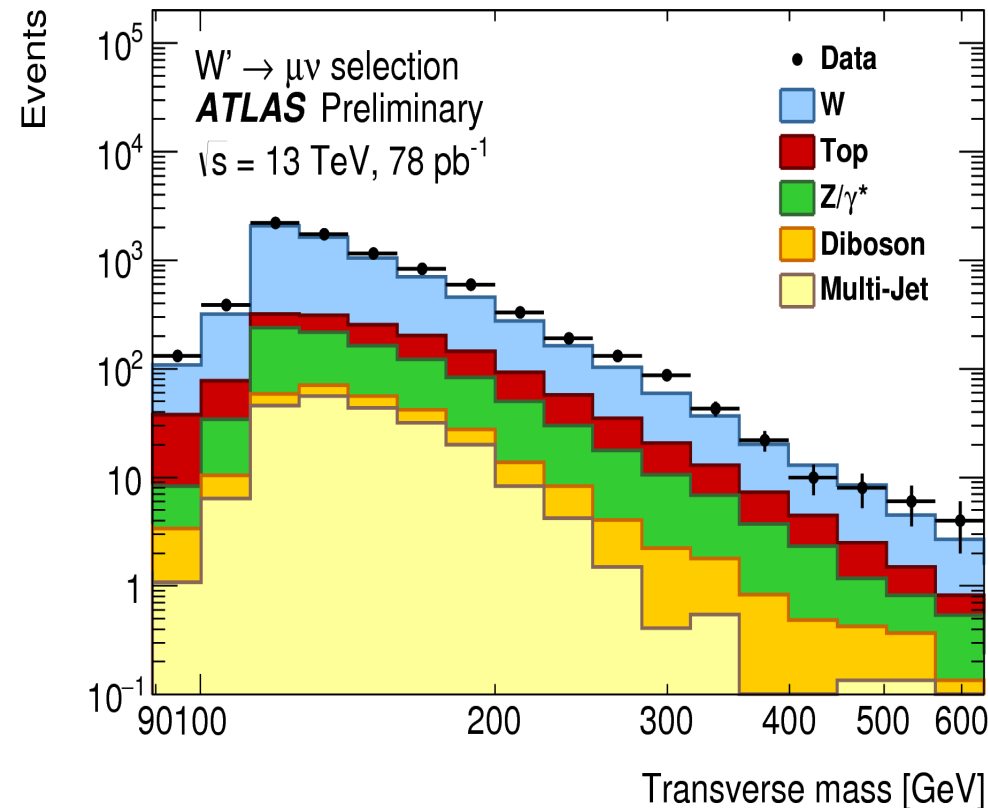


Di-Lepton Final States ($e\mu$)

- Search for lepton flavor violation in charged lepton sector
- Single lepton trigger selects events
 - Require two opposite flavor leptons with $p_T > 30$ GeV
- Calculate invariant mass of lepton pairs
 - Normalize MC prediction to observed data in low mass region
 - $M_{ll} < 300$ GeV



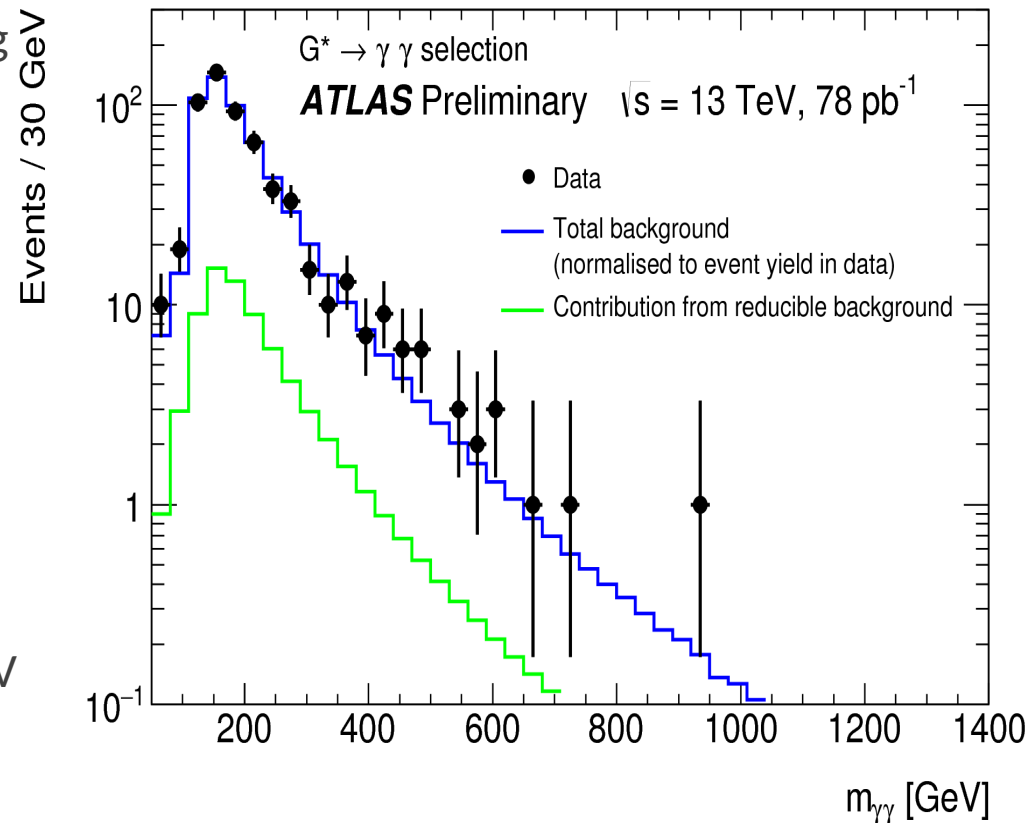
Di-Lepton Final States ($e\nu, \mu\nu$)



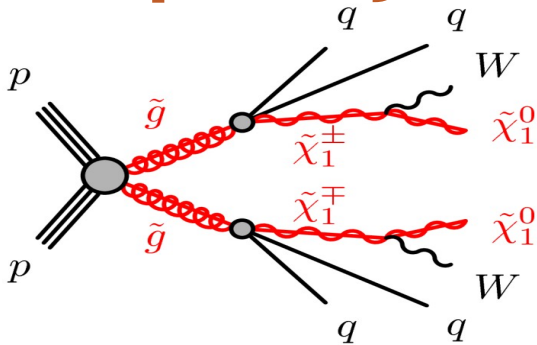
- Search for charged resonances decaying to lepton pairs
 - Sign of a new fundamental symmetry
- Single lepton trigger selects events
 - Require one charged lepton with $p_T > 65$ (55) GeV for $e(\mu)$
 - Balanced by missing transverse momentum
- Calculate transverse mass of lepton pairs
- Highest transverse mass event in electron channel 1050 GeV
- Highest transverse mass event in muon channel 966 GeV

Di-Photon Final States

- Search for new resonances decaying to pair of photons
 - Ex: RS Gravitons
- Photons must be isolated in calorimeter and have $E_T > 55$ GeV
- Calculate invariant mass of photon pairs
 - Normalize MC to observed number of data events
- Highest mass photon pair is 940 GeV

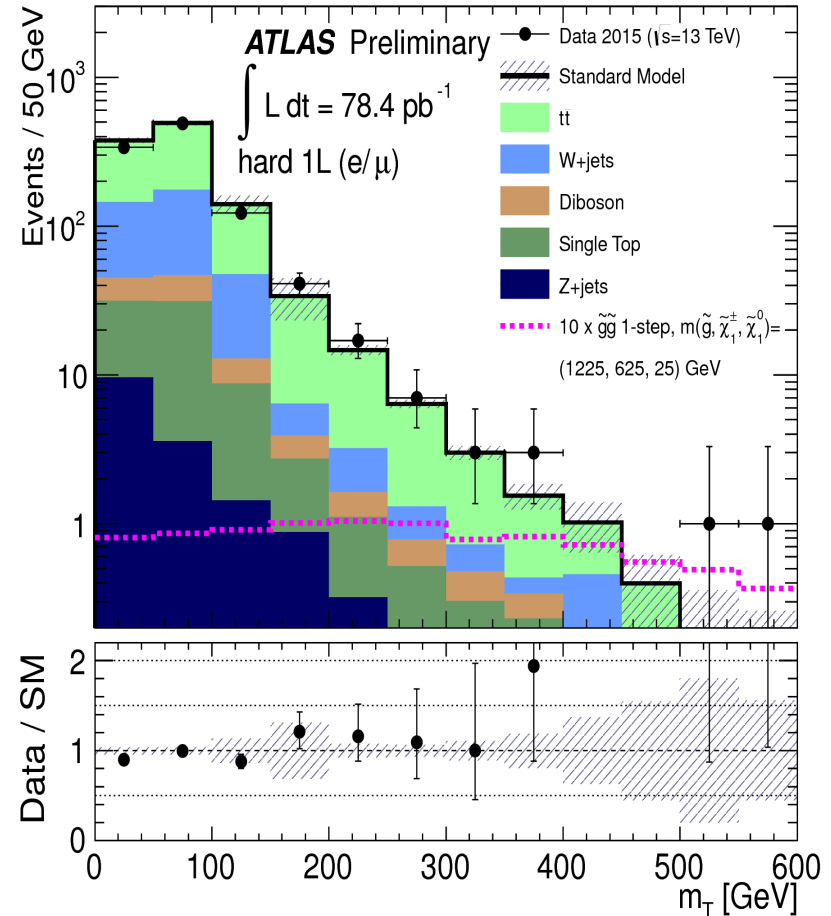


One Lepton, Jets, & Missing Energy

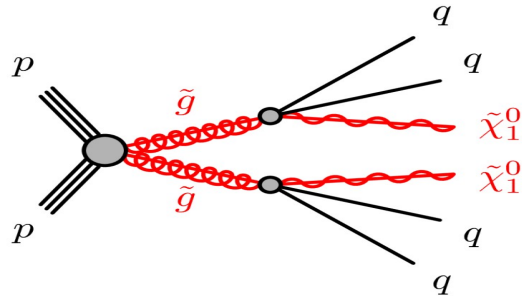


Run-I: 1501.03555/1507.05525

- Search for colored super partners
 - Calibration and validation of control regions
- Ultimately searches for squarks and gluinos in final states with jets, missing transverse momentum, and one lepton
- Calculate transverse mass in high multiplicity events
 - One isolated lepton $p_T > 30$ GeV
 - 2-4 jets $p_T > 30$ GeV
 - $E_{t,miss} > 100$ GeV
- Sensitivity over the Run-I search expected with ~ 3 fb $^{-1}$

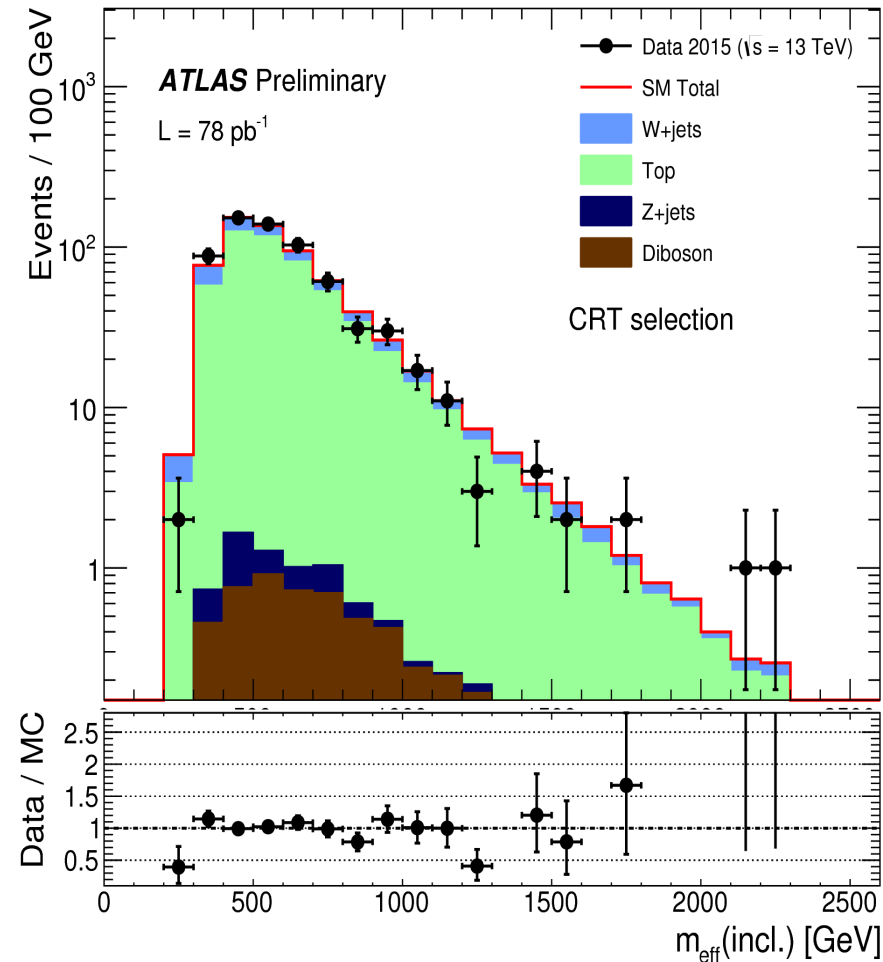


No Leptons 2-4 Jets + Missing Energy



Run-1: 1405.7875/1507.0525

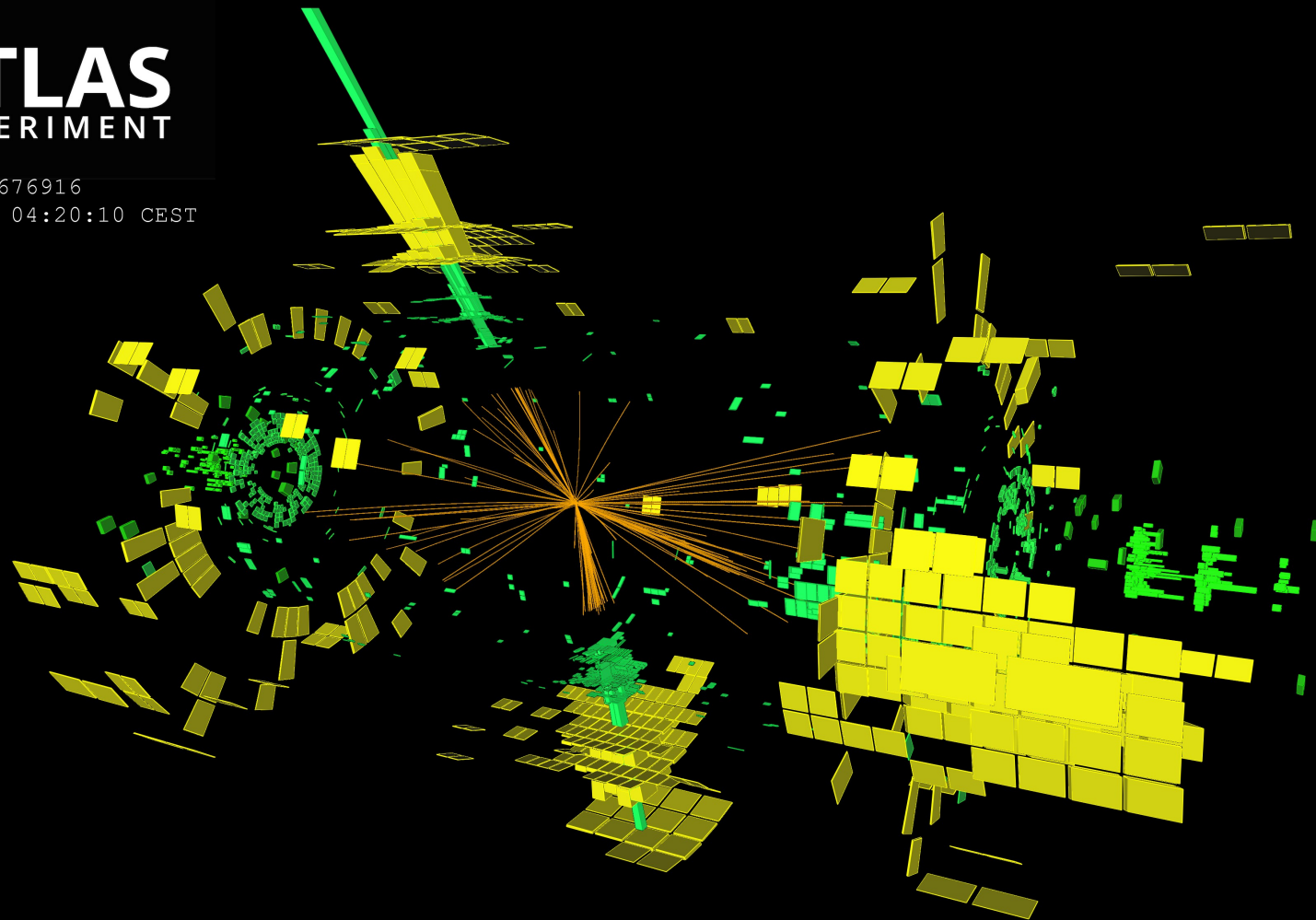
- Search for colored super partners
 - Calibration and validation of control regions
- Ultimately searches for squarks and gluinos in final states with jets, and missing transverse momentum
- Calculate scalar sum of transverse momentum of objects in events m_{eff}
 - Three control regions for W, Z, and top events
- Top control region selected with m_T requirement
 - $30 < m_T < 100$ GeV
- Good purity in background control regions
- MC distributions normalized to the observed data
- Sensitivity over Run-I search expected with ~ 3 fb⁻¹



Search Results

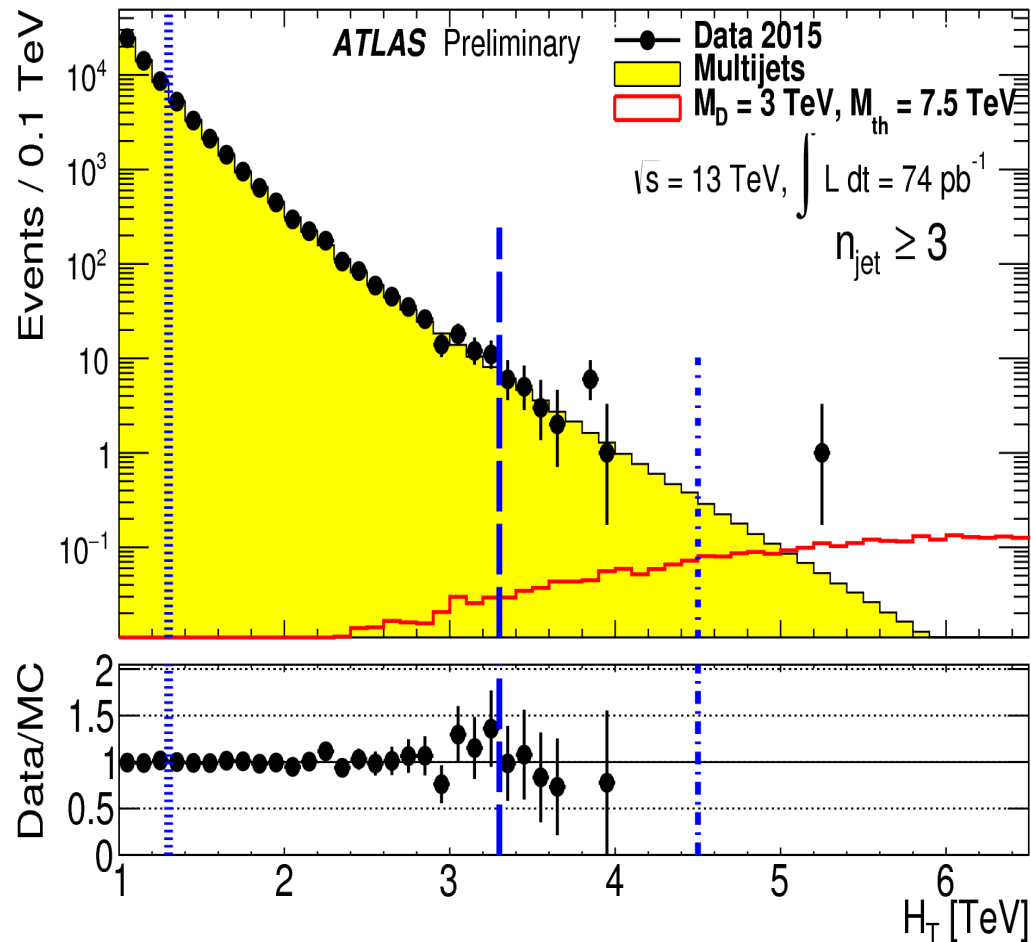


Event: 531676916
2015-08-22 04:20:10 CEST

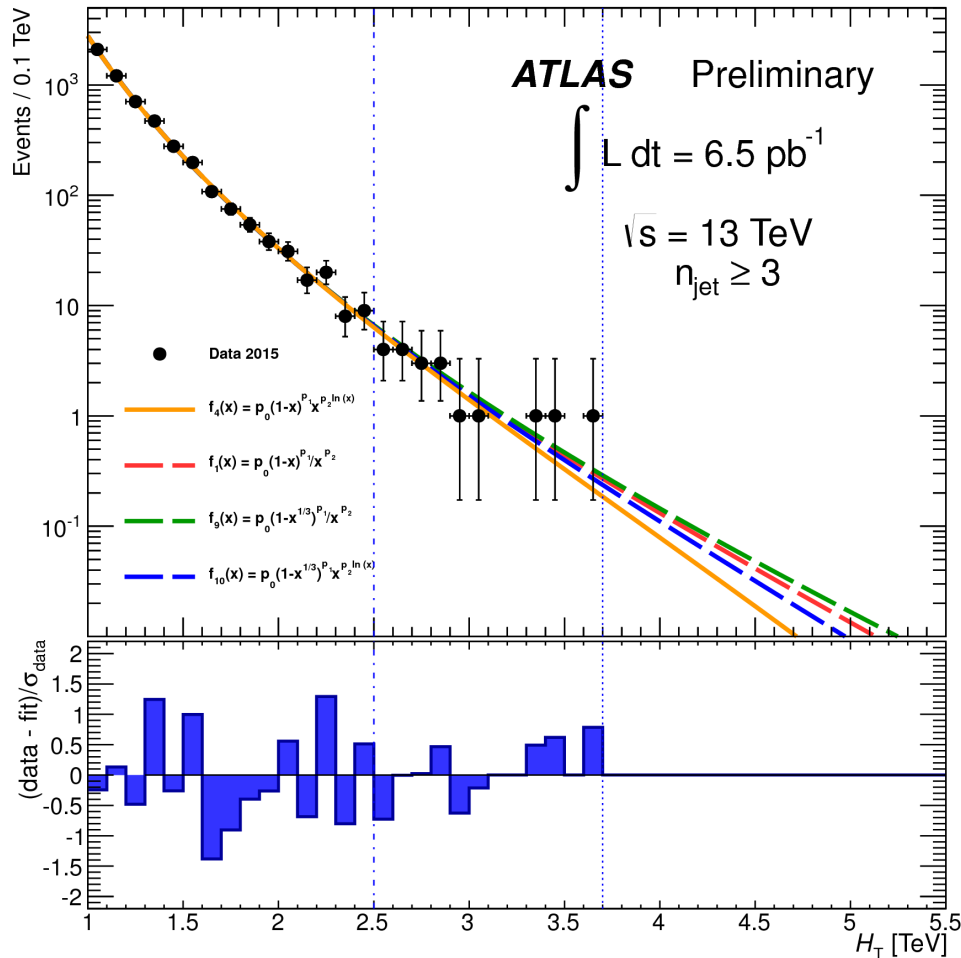


Search for Evidence of Strong Gravity

- Search for evidence of strong gravity in jet multiplicity bins
 - Dramatic threshold signals
- Require events to have at least three jets with $p_{T} > 30$ GeV
- Calculate scalar p_{T} sum of jets in the event H_{T}
 - MC is normalized to observed Data in low- H_{T} control region
 - Normalization is validated in intermediate- H_{T} region
 - Extrapolated into signal region at high- H_{T}
- Spectrum is fit with analytic functions
 - Signal is searched for by testing consistency in high- H_{T} signal region
 - Data split into two periods 6.5 pb⁻¹ for validation and 74 pb⁻¹ for search



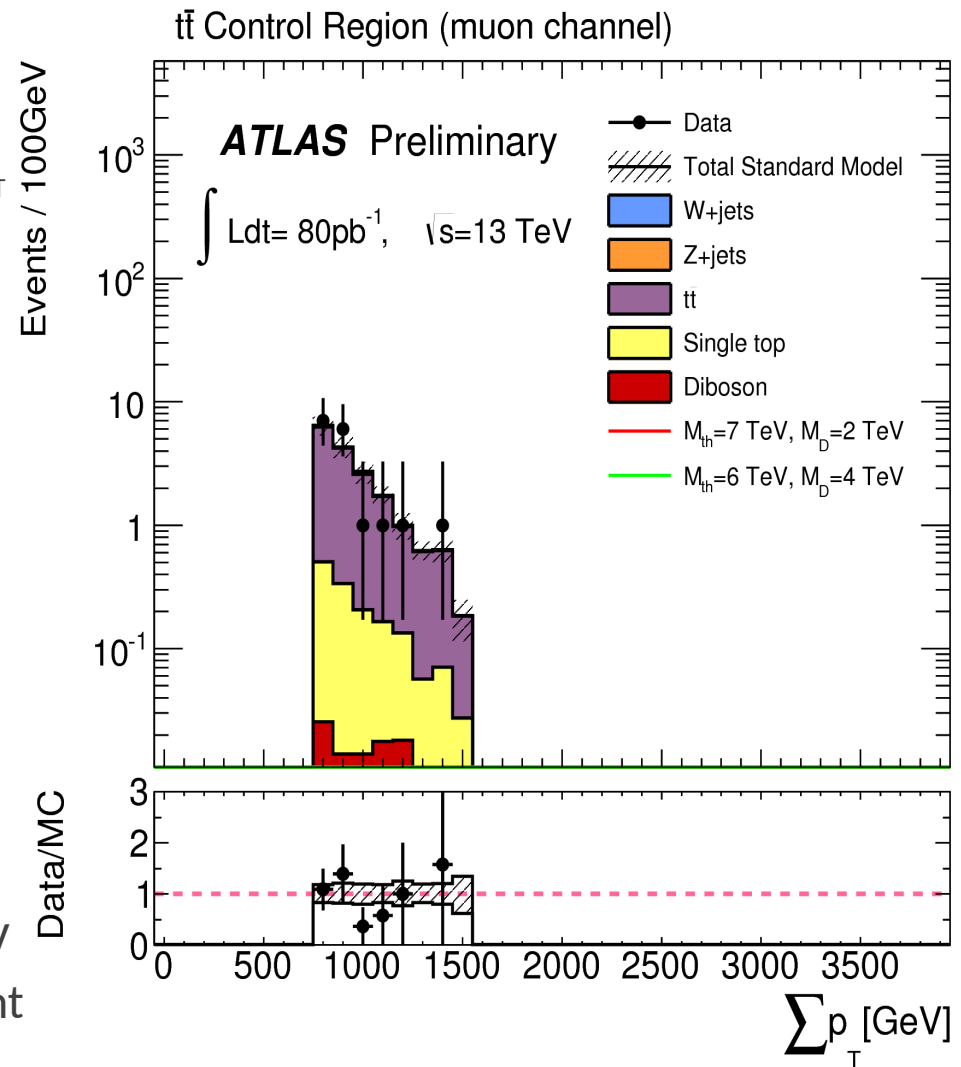
Search for Evidence of Strong Gravity - Results



- Jet multiplicity bins combined for final fit
 - Expect 1.4 events in SR observe 1
- **No significant deviation from background only hypothesis**
 - Set 95% CL limits on models of low scale gravity using CHARYBDIS2
 - 2D plane of $M_D - M_{\text{TH}}$

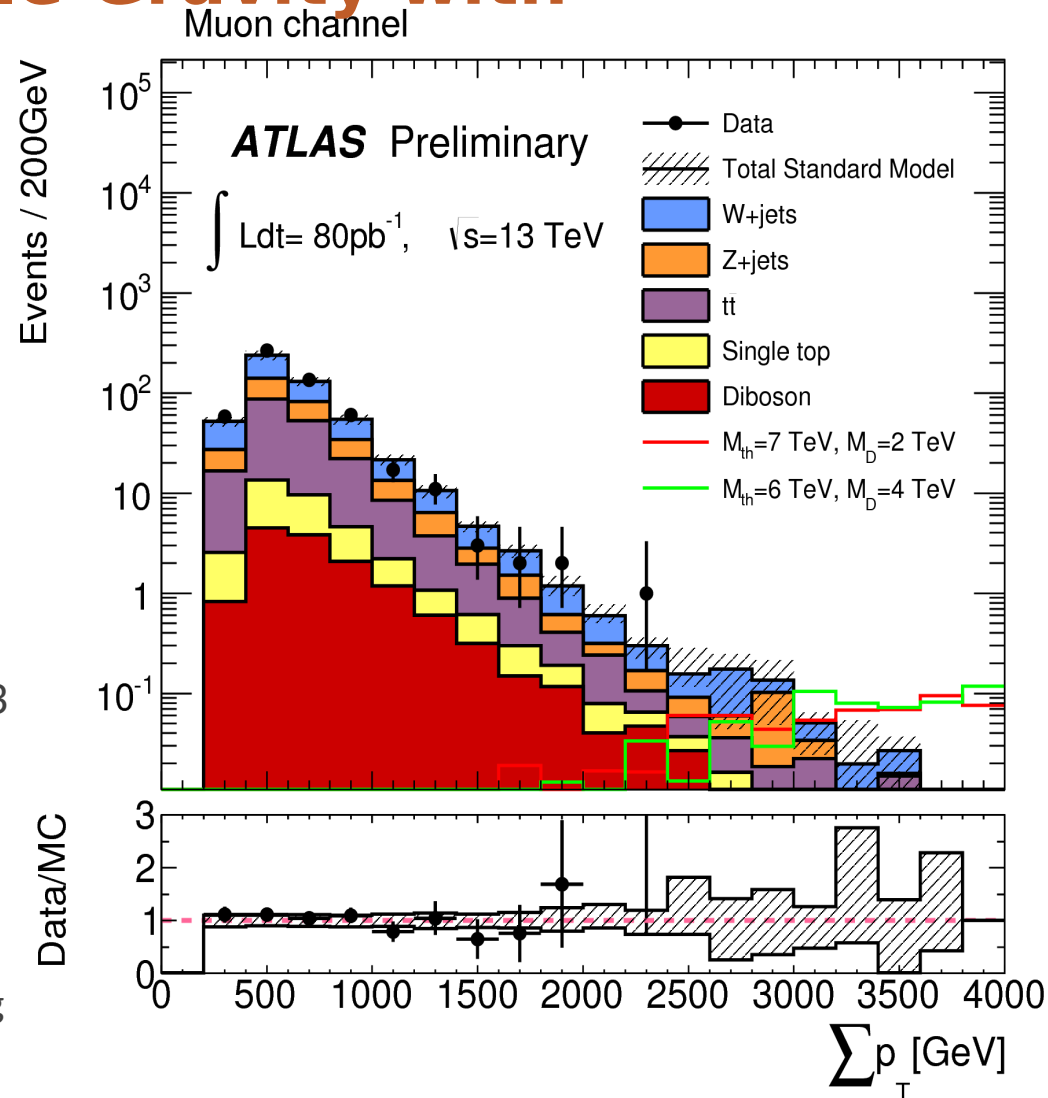
Search for TeV Scale Gravity with Leptons and Jets

- Search for evidence of strong gravity in H_T spectrum
 - Dramatic threshold signal
- Single lepton triggers select events
 - Events categorized based on highest p_T lepton
- Calculate H_T of all objects in the event
- Control Regions for W, Z, and top backgrounds
 - Validation Region to test consistency
- Signal Regions where lepton $p_T > 100$ GeV plus two other 100 GeV objects, and event $H_T > 2$ TeV or 3 TeV



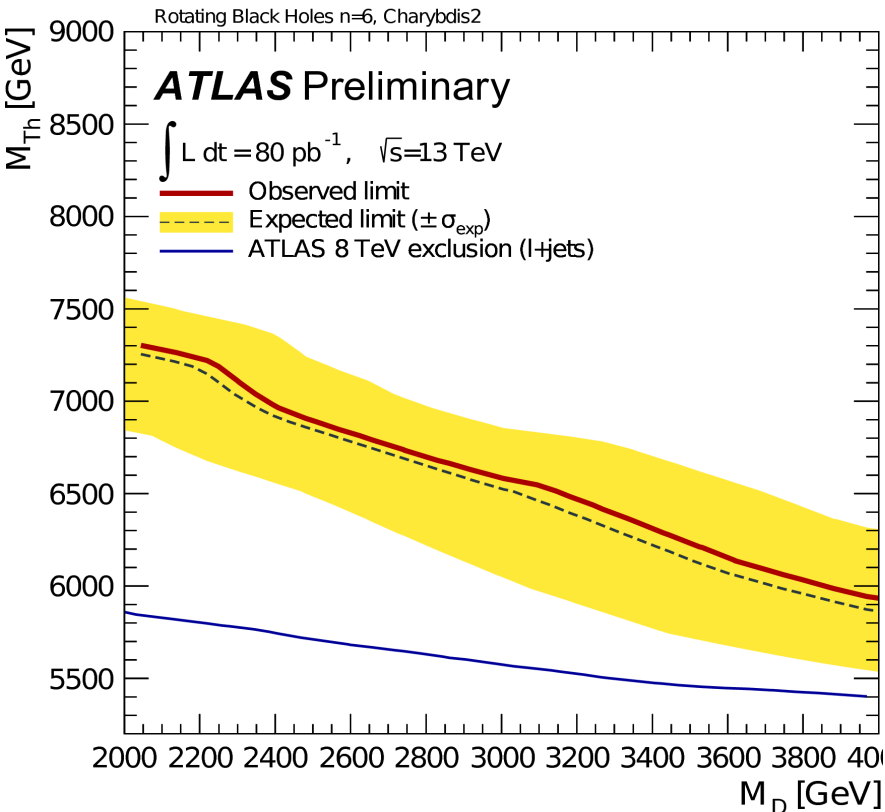
Search for TeV Scale Gravity with Leptons and Jets

- Control region fits are extrapolated to high H_T region
 - Profile likelihood fits of W, Z, top contributions
- Validation region w/ H_T between 1.5- 2.0 TeV
- Signal appears at high- H_T
- In 2(3) TeV Signal Regions expected 5.3 (0.3) event from SM fits
 - Observed 5 and 0
- No significant deviation from background only hypothesis**
 - Set 95% CL limits on models of rotating black holes using CHARYBDIS2
 - Limits set in 2D M_D vs M_{TH} plane

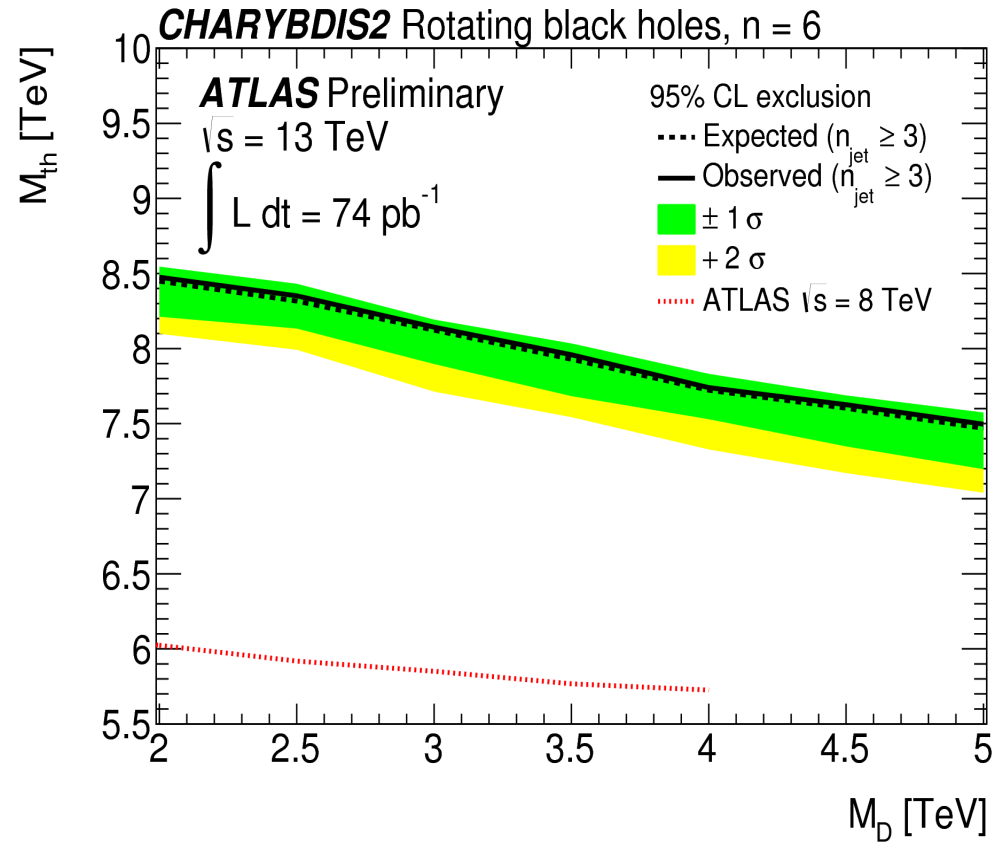


Search for TeV Scale Gravity - Results

ATLAS-CONF-2015-046



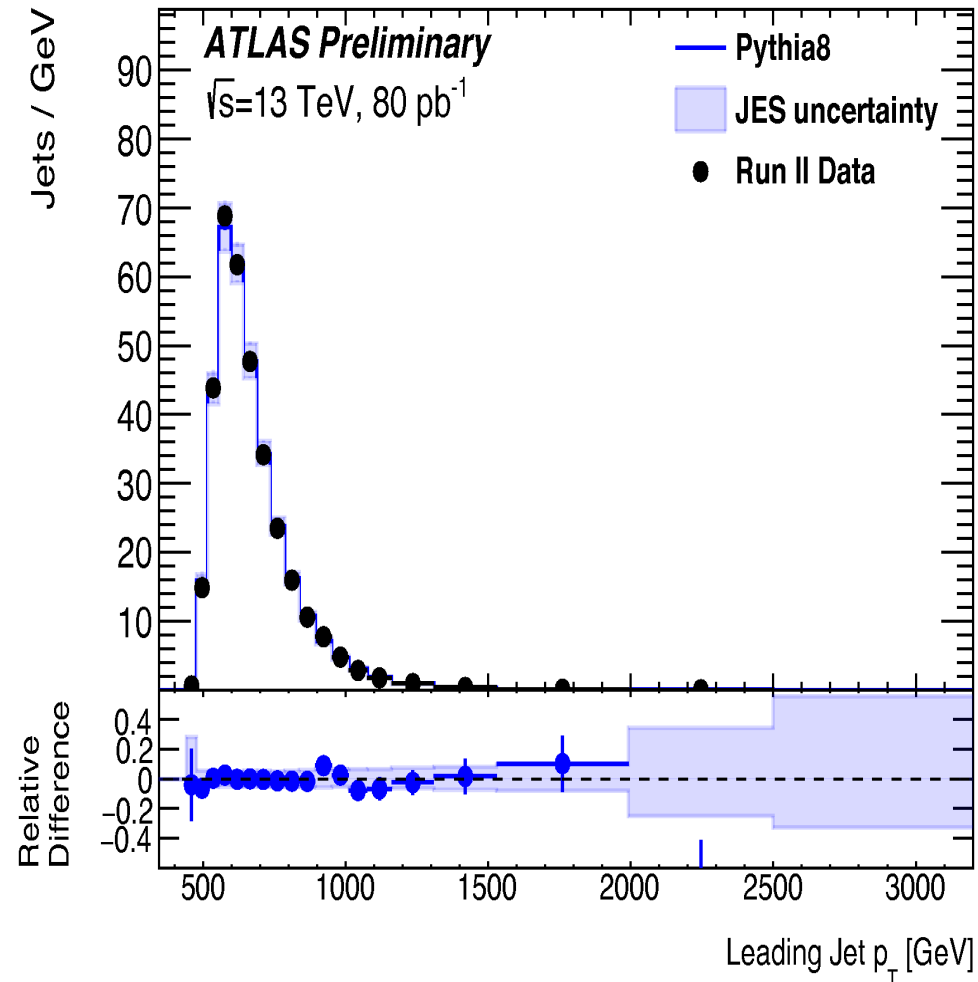
ATLAS-CONF-2015-043



- In both leptonic and hadronic channels Run-II 95% CL limits already surpass Run-I analysis!

Searches In Di-Jet Final States

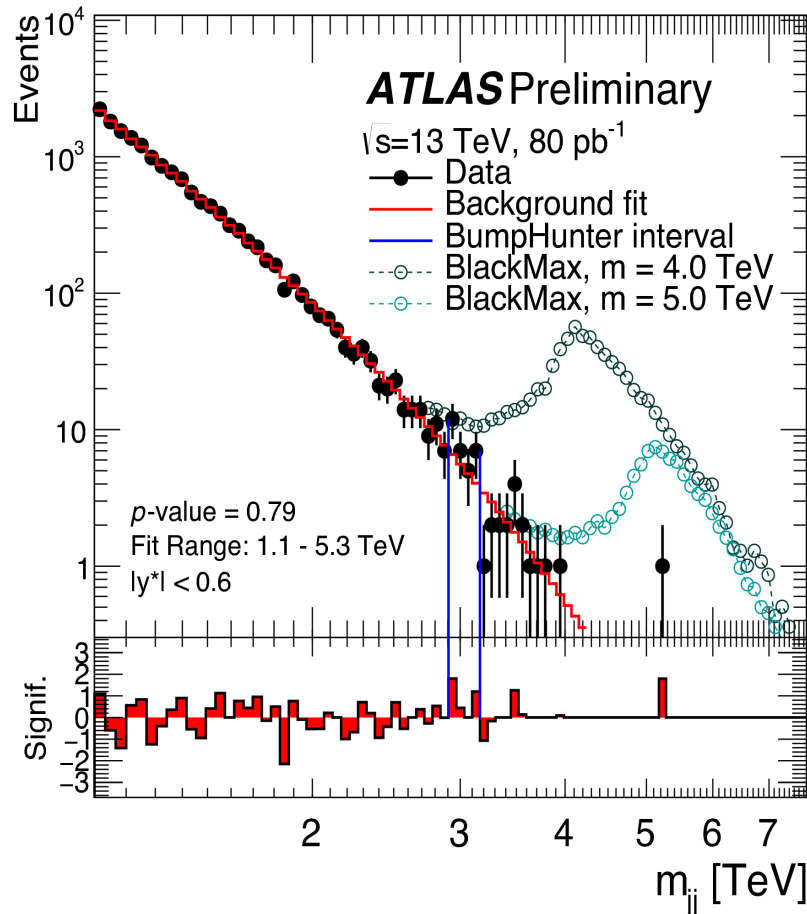
- Search for non-SM features in di-jet final states
 - New resonances in m_{jj}
 - Deviations in angular variables
- For resonance search
 - Select events with leading(subleading) jet has $p_T > 410(50)$ GeV and $|y^*| < 0.6$
 - Calculate invariant mass m_{jj}
- For angular analysis
 - Select events with leading(subleading) jet has $p_T > 410(50)$ GeV and $|y^*| < 1.7$ and $|y_B| < 1.1$
 - Calculate angular variable χ



$$y^* = \frac{1}{2}(y_1 - y_2)$$

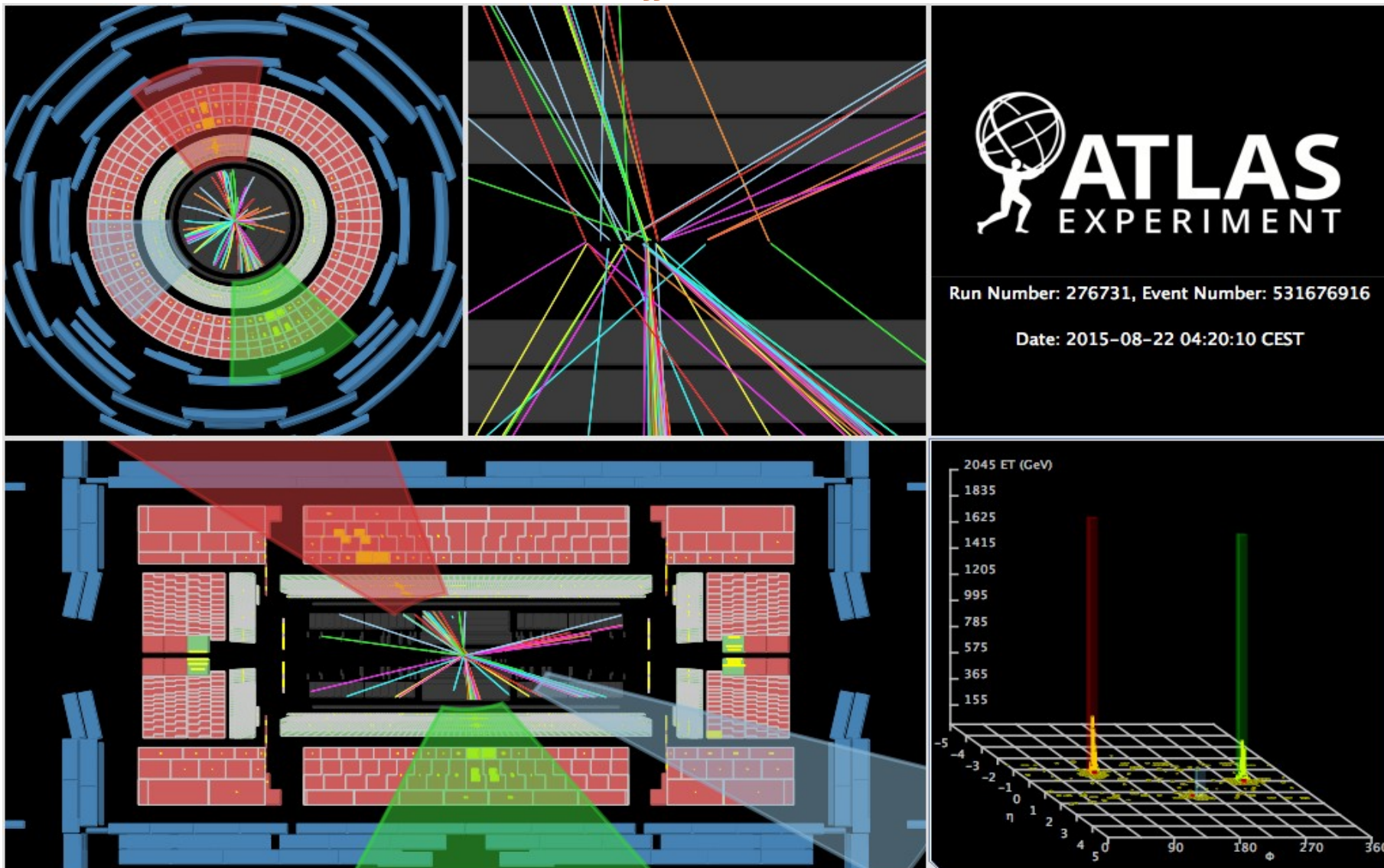
Di-Jet Resonances Search

$$f(z) = p_1(1 - z)^{p_2} z^{p_3 + p_4 \log z} \quad z \equiv m_{jj} / \sqrt{s}$$



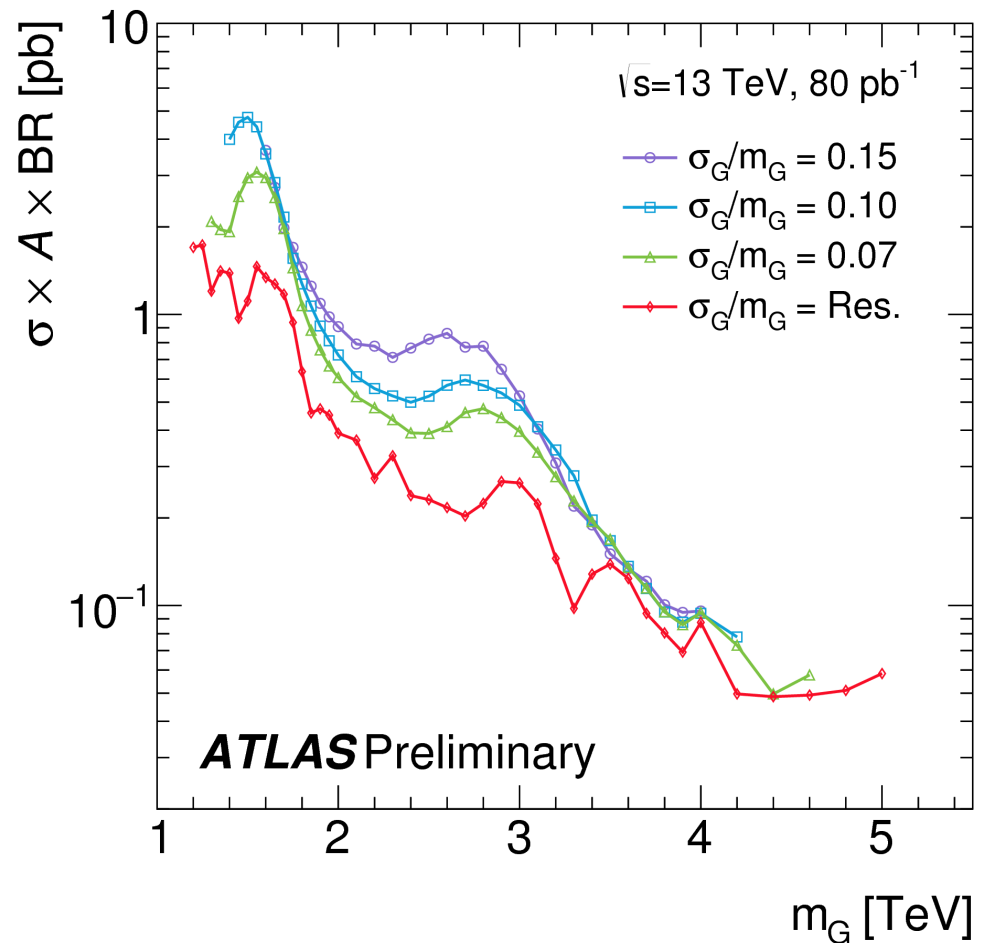
- Fit m_{jj} distribution with analytic function
- Compare fit with observed data using BumpHunter
 - Most discrepant region identified as 2.9 - 3.2 TeV
 - $p\text{-value}$ of 0.76
- **Consistent with background only hypothesis**
- Highest mass event is 5.2 TeV

Di-Jet Event with $m_{jj} = 5.2$ TeV!



Di-Jet Resonances Search - Results

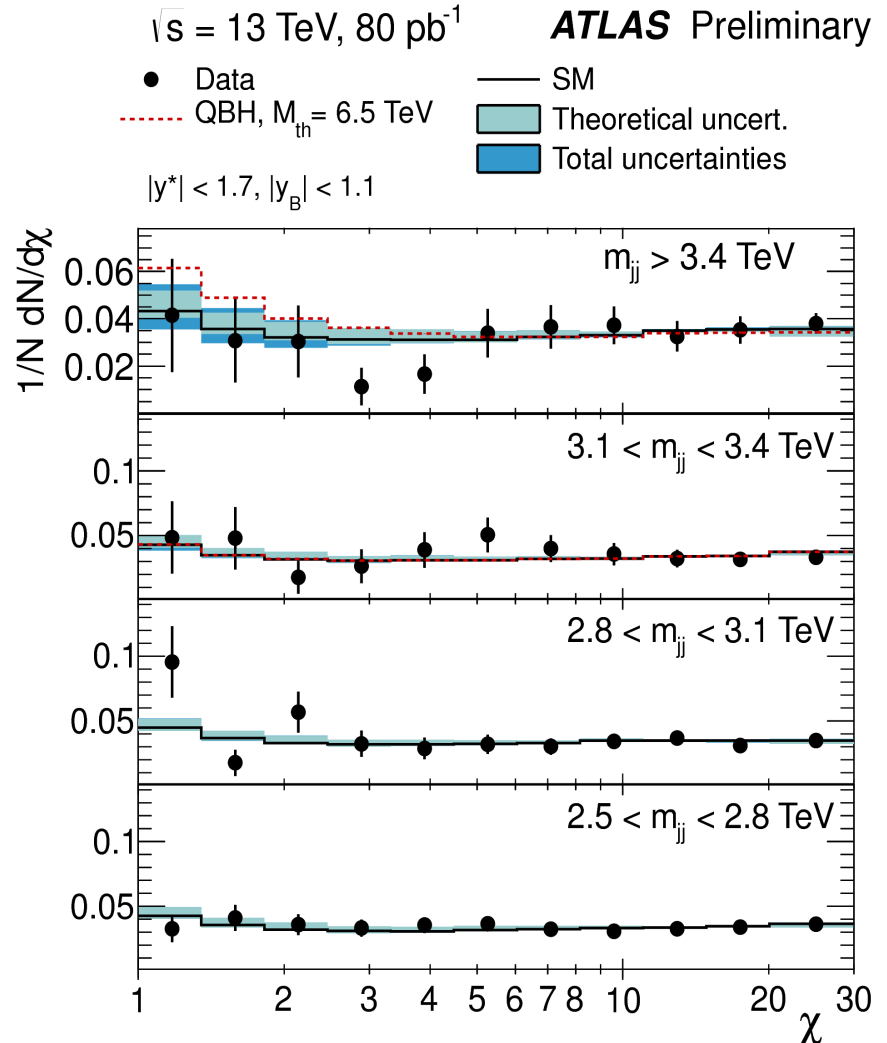
- 95% CL limits are derived for a Gaussian signal as function of resonance width
- Signal hypothesis for ADD Graviton using BlackMax and Quantum Black Hole MC generators
 - For all signals $M_D = M_{th}$ and $n=6$
- The resonant search excludes $M_{th} < 6.8$ TeV at 95% CL using QBH
 - Using BlackMax $M_{th} < 6.5$ TeV excluded at 95% CL



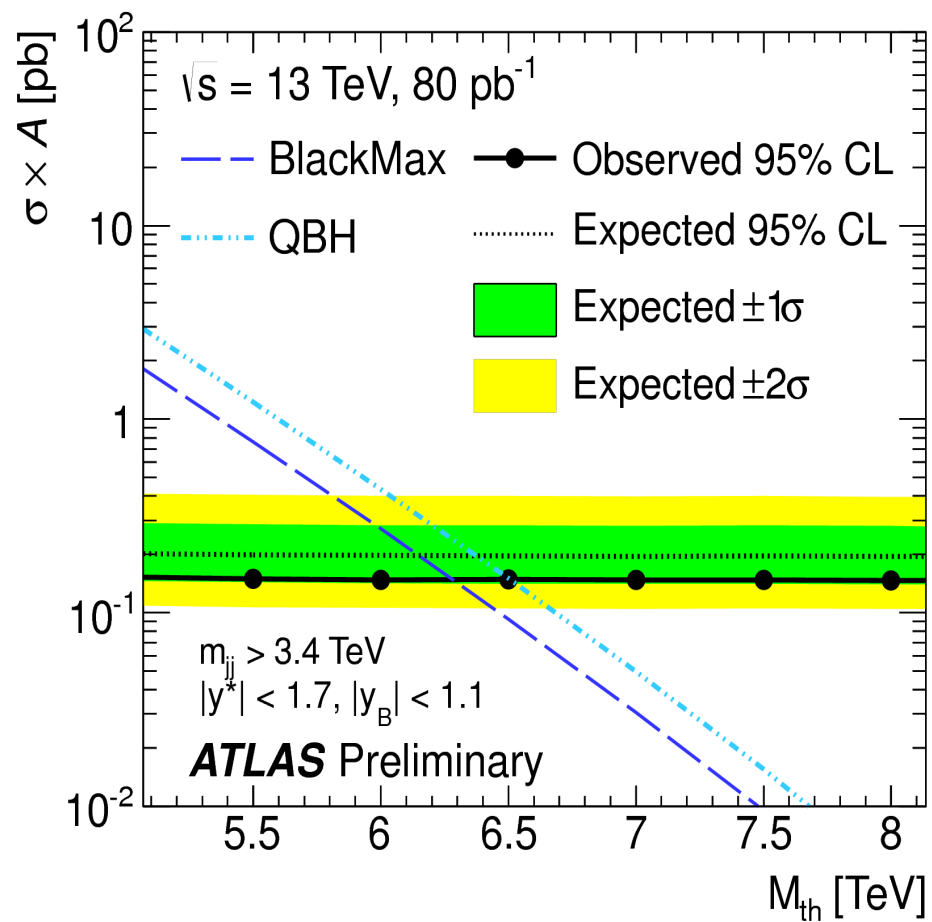
Di-Jet Angular Search

$$\chi = e^{2|y^*|} \sim \frac{1 + \cos \theta^*}{1 - \cos \theta^*}$$

- For events with m_{jj} over 2.5 TeV the χ distribution is tested for consistency with the SM
 - Performed in bins of m_{jj}
- SM prediction from PYTHIA8 corrected in m_{jj} and χ using NLOJET++
- QBH signal would appear as excess in low χ bins
- The p-value of the background only hypothesis to the data is 0.5
- **No significant deviation is observed**



Di-Jet Angular Search - Results



- 95% CL limits are derived for ADD models of gravity as function of M_{TH}
- The angular search excludes $M_{\text{th}} < 6.5 \text{ TeV}$ at 95% CL using QBH
 - Using BlackMax $M_{\text{th}} < 6.4 \text{ TeV}$ excluded at 95% CL

Summary and Conclusions

- ATLAS has recorded 319 pb⁻¹ of 13 TeV data
 - Two periods of 80 pb⁻¹ used in public results
- Re-establishing understanding of high momentum objects
 - Leptons, photons, jets, missing transverse momentum, H_T
- Relaxed cuts have been used to validate control regions and analysis techniques where sensitivity has not yet passed Run-I analyses
- Using the Run-II data ATLAS has performed searches in a number of final states
 - ***No significant deviation from the background only hypothesis is observed.***
 - Searching for signs of Strong Gravity in hadronic and lepton plus jets final states
 - Setting limits in a two dimensional plane
 - Search for Gaussian signal and Quantum Black Holes in di-jet final state
 - Excluding M_{th} below 6.8 TeV using both a resonant search and angular analysis
- More searches are right around the corner!

Additional Material